

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
26 February 2004 (26.02.2004)

PCT

(10) International Publication Number  
**WO 2004/016097 A1**

- (51) International Patent Classification<sup>7</sup>: **A23J 3/22**, A23B 7/08
- (21) International Application Number: PCT/AU2003/001045
- (22) International Filing Date: 18 August 2003 (18.08.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 2002950897 16 August 2002 (16.08.2002) AU
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- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).
- Published:**  
— with international search report
- For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

WO 2004/016097 A1

(54) Title: **SHELF STABLE MEAT ANALOGUES COMPRISING GLYCEROL AND GLUCOSE**

(57) Abstract: The invention relates to a method of manufacturing a texturised proteinaceous meat analogue having a relative water activity of less than about 0.8, comprising proteinaceous materials selected from the group consisting of defatted soy flour, soy meal, soy concentrate, cereal gluten (in vital or starch containing form) and egg white powder, edible binding and cross-linking compounds, and a humectant of glycerol and glucose, and the products thereof. The mixture is converted into hot lava, extruded and cooled.

## SHELF STABLE MEAT ANALOGUES COMPRISING GLYCEROL AND GLUCOSE

### FIELD OF THE INVENTION

The present invention broadly relates to the manufacture of edible  
5 proteinaceous products, in particular texturised protein products (TPP's) for  
human and/or animal consumption. In particular, the invention relates to a shelf-  
stable TPP of intermediate moisture and a method and apparatus for the  
manufacture of same.

### BACKGROUND OF THE INVENTION

10 The industrial manufacture of meat analogue products from protein-rich  
precursor materials, including plant based precursors such as cereal grain protein  
(of wheat, rice, or maize; vital or with residual starch), defatted oil seed, cereal  
and bean flours, meals and derivatives (e.g. defatted soy flour, soy protein  
concentrates, wheat flour), or animal based precursors such as meat by-products  
15 obtained by mechanical separation, fish meal, dried egg white powder and others,  
alone or in combination, is a well-established practice. Extrusion cooking  
technology is the most widely used of different possible manufacturing methods  
to obtain such meat analogues.

The general state of the prior art with respect to such products and  
20 processes for their manufacture is surveyed in detail in patent document No. WO  
00/69276, by Effem Foods Pty Ltd. This document discloses a method of  
manufacturing a texturised protein product that mimics the appearance of flaked  
fish meat, shredded chicken meat or other meat products, as well as an  
apparatus for manufacturing such product. In particular, the document discloses a  
25 suitable formulation for a texturised protein product that enables the TPP to be  
formed in a high-moisture, extrusion cooking process, and to be mechanically  
shredded into flakes that closely resemble an animal protein product in texture  
and structure, such as flaked fish meat or shredded chicken meat.

However, the technology disclosed in WO 00/69276 does not provide a  
30 TPP that is suitable for all desirable applications. For example, it is desirable to  
include such "visually authentic" pieces as a direct inclusion in 'dry' or semi-moist  
packeted pet foods (as compared to moist, canned pet foods), in order to  
reinforce the impression to the purchaser that the product contains 'real' fish or

chicken. The relatively high moisture levels of the product disclosed in WO 00/69276 would prevent their direct inclusion in such dry or semi-moist packeted products, as their moisture content would impart a limited shelf life to the overall product, reducing their commercial feasibility. Inclusion of such TPP products in  
5 an unsterilised, packeted environment would be likely to lead to spoilage via the development of mould or other spoilage organisms within a few hours of manufacture. In order to be commercially feasible, the shelf life of packeted products, which are usually not sterilized, needs to be at least nine months, and preferably 12 months, thus making the inclusion of high-moisture TPP difficult.

10 An obvious solution to this problem would be to dry the TPP in order to decrease its relative water activity to  $<0.8$  in order to significantly reduce the activity of spoilage organisms. However, this would significantly increase the hardness of this type of TPP, thereby greatly decreasing its acceptability to the animal.

15 In this document, the term 'relative water activity' is used according to the meaning it is usually accorded in the art, that being the proportional availability of the present water molecules to react relative to pure liquid water.

Reformulation of the TPP may be undertaken in order to reduce water activity, such as by increasing the cereal content. However, such reformulations  
20 will tend to have deleterious effects on the texture and palatability of the TPP, and may also adversely affect the ability of processing equipment to effectively produce the TPP in the desired form. For example, general decreases in formulated moisture levels will lead to greater work being done by the extruder screw as the material passes through it. This results in greater heat development  
25 in the material, which may lead to expansion, or 'puffing' of the product. As this would tend to ruin the non-expanded, striated, meat-like appearance intended, such a solution is not desirable.

A common way to reduce water activity while maintaining product texture is to incorporate one or more humectant materials in the formulation. However, for  
30 the type of product described in WO 00/69276, i.e. high-moisture extruded TPP, it has been found that many of the common humectant systems do not provide a solution to the problem. The incorporation of sugars at 12% by mass of the formulation, as used in other semi-moist pet foods, tended to cause blockages

and product burning in the high-shear twin-screw extruders that are necessary for the manufacture of this type of product.

Similarly, the use of a lower viscosity humectant material, such as a sugar solution, resulted in an inability of the process to provide the correct 'striated' texture for the product. This is because lower viscosity / higher fluid content feedstocks are not capable of producing a textured extrudate, especially for this type of extrusion.

Other liquid humectants, such as propylene glycol, are available for extending the shelf life of such TPP products. However, these materials also tend to compromise the texture of the product when added at the levels necessary to produce the shelf-life extension sought. Furthermore, propylene glycol is not suitable for TPP that is to be fed to felines, as it is toxic for these animals. It also tends to produce a flavour taint that is undesirable.

Therefore, it is an object of the invention is to provide a TPP having visual and textural properties similar to those described in WO 00/69276, but with a significantly extended shelf-life, such that it does not require further sterilisation processing. It is another object of the invention to provide a process for the manufacture of same.

#### **SUMMARY OF THE INVENTION**

Accordingly, in a first aspect of the present invention, there is provided a method for manufacturing a texturised proteinaceous meat analogue product, having a relative water activity of lower than about 0.8, said method including the steps of:

subjecting, in a food-extruder, a mixture containing about 20 to 80% by weight edible proteinaceous materials selected from the group consisting of predetermined mixtures of defatted soy flour, soy meal, soy concentrate, cereal gluten (in vital or starch-containing form) and egg white powder; up to about 5% by weight of edible mineral binding and cross-linking compounds; and up to about 50% by weight of an edible humectant system consisting of a mixture of glycerol and glucose of predetermined ratio; to mechanical pressure and added heat sufficient to convert the mixture into a hot protein lava; and

extruding the protein lava through and from a temperature controlled cooling die which cools and increases the viscosity of the protein lava to obtain a

cohesive, texturised, extrudate slab or ribbon in which vapour-flashing is substantially inhibited.

Preferably, the product contains about 25% by weight glycerol and about 5% by weight of glucose. The presence of these humectants allows the TPP to  
5 maintain a texture that is soft enough to be acceptable to the consumer, while reducing the water activity to a level that allows a shelf life of at least 12 months in ambient conditions. Unexpectedly, this combination of liquid humectant ingredients does not produce a deleterious effect on product texture or on the ability of the equipment to successfully process the materials. The water activity  
10 of the final product can be advantageously set to between about 0.55 and about 0.68.

Preferably, the temperature of the product components in the extruder is minimised by using a twin-screw extruder with five barrel sections and a screw speed in the range 300rpm to 550rpm, and even more preferably about 500rpm.  
15 The temperature of the molten lava is preferably restricted to <120°C.

Preferably, the solidified extrudate slab or ribbon is subjected to suitable size-reduction techniques for producing extrudate shreds that resemble in consistency and texture flaked or shredded meat.

Preferably, the size reduction is performed by shredding in a hammer mill  
20 having a cage plate with a plurality of elongate discharge openings and a plurality of hammer bars hinged to discs attached to a rotating shaft. Use of the hammer mill as described advantageously enables the manufacture of extrudate shreds that resemble, in consistency and texture, flaked fish meat, shredded chicken meat or shredded red meat (such as beef or lamb).

25 In performing the above method, addition of real meat or meat by-product into the TPP mass is an optional step to enhance flavor and to provide animal protein contents. This addition may occur prior to, during or after the step of subjecting the mixture to mechanical pressure and heat. Preferably, the addition of the meat product or meat by-product occurs during the extrusion step. This  
30 real meat or meat by product may be obtained from fish, poultry or from livestock (such as cattle or sheep).

Advantageously, the extrudate is transferred directly from the cooling die to the hammer mill for shredding, as shredding or flaking the extrudate whilst the

extrudate slab is still warm provides shreds or flakes of more authentic appearance. Therefore, typically, the time between extrusion and cutting should not exceed 5 minutes.

Preferably, the mixture referred to above has total moisture content of  
5 between about 15% and about 40% by mass.

It will be understood that the extrudate can be conveyed as a continuous band or ribbon directly into the hammer mill, or it may be conveyed in shorter lengths or discontinuous portions.

A preferred formulation of the meat analogue product, which results in  
10 extrudate shreds that substantially mimic tuna fish flakes, that can be blended directly into a packeted pet food product, consists of: a dry ingredient mixture, making up about 50% of extrudate mass, consisting of about 40% defatted soy flour, about 40% vital wheat gluten, about 0.5% nutritional vitamin supplements, about 8.5% mineral supplements, about 2.0% flavouring agents, about 4.3%  
15 colouring agents and about 4.7% carbohydrate (all weight %); a humectant blend, making up about 30% of extrudate mass, consisting of about 83% glycerol and about 17% glucose; and injected meat material, making up about 20% of extrudate mass, consisting of comminuted material derived from chicken, fish or livestock.

20 As disclosed in WO 00/69276, a conventional hammer mill, which is generally employed to grind, particulate or pulverise dry, relatively hard materials such as coal, grains, seeds and similar dry materials, can be employed with a modified screen in accordance with this aspect of the invention to shred the proteinaceous, plasto-elastically-resilient, and moisture-rich extrudate slab or  
25 ribbon into chunks or pieces that closely resemble in appearance those of shredded tuna fish meat or chicken meat, without otherwise adversely affecting the structure and texturisation of the TPP shreds.

The cooling die may be adapted so as to form an extrudate slab or ribbon having any suitable cross-section (e.g. rectangular or circular).

30 A production line incorporating the inventive method may be arranged such that continuous manufacturing of shredded TPP extrudate is achieved from metering of the dry ingredients and water into the extruder to metering the extrudate shreds into appropriate vessels for further processing. Alternatively, a

further conveyor means can be disposed underneath the hammer mill discharge chute for conveying the meat analogue shreds towards further processing units of an integrated food production line, (e.g. a canning station or the like).

In a further refinement, it has been found to be particularly advantageous in conducting the manufacturing process to employ a conveying and pressurising twin-screw extruder with 4 to 6 barrel sections that are individually temperature controlled, each section having a length to diameter ratio of approximately 4, as used in high moisture extrusion cooking. Temperature settings at the individual barrel sections during the manufacturing process will vary between 60 and 150 °C and internal pressure between 3 and 8 MPa, at screw speeds of between 300 to 550 rpm.

In a second aspect, the present invention provides a shredded meat analogue product manufactured in accordance with any one of the processes described above using the formulation of materials referred to above.

Further features and advantages of the invention will be described in the following in relation to preferred embodiments thereof by way of a specific, non-limiting example.

#### **DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT**

The following non-limiting description of a preferred embodiment of the invention is presented with reference to the TPP product, and the manufacturing processes and equipment therefor, as described in detail in patent document No. WO 00/69276.

A TPP product having a fibrous striated structural matrix and resembling tuna white-meat was prepared generally according to the process and formulation details given in Example 2 in the preferred embodiment description of WO 00/69276, except with the changes to formulation and process conditions outlined as follows:

The ingredients listed in Table 1 were weighed out as indicated there, milled through a hammer mill fitted with a screen of size 1.2 - 2 mm and pre-blended in a ribbon blender for 4 minutes.

Table 1

<u>Ingredient</u>	<u>% by mass</u>
Defatted soy flour	40

	Vital wheat gluten	40
	Vitamins	0.5
	Minerals	8.5
	Carbohydrate	4.7
5	Flavouring agents	2.0
	Colouring agents	4.3

Added to this mix was a blend of humectants, consisting of 83% glycerol by weight and 17 % glucose by weight. This blended mixture was then fed into the hopper and metered into the extruder (Werner & Pfleiderer C58, fitted with 5 barrel sections) at a rate of 138kg/hr. Comminuted tuna-derived material was injected into the molten material at a rate such that the overall mass-flow ratio of dry material:humectants:tuna material was approximately 5:3:2. The extruder screw speed was set at 530rpm. Temperatures of the barrels were regulated to the values listed in Table 2.

Table 2

	<u>Barrel number</u>	<u>Temp °C</u>
	1	20
	2	50-60
20	3	70-80
	4	100-110
	5	110-120

The dry precursor materials are plasticised and molten into a viscous extrudate as they are conveyed through the extruder barrel sections. The hot melt is extruded through the breaker plate. The extrudate leaving the breaker plate enters the cooling die channel member (cross-sectional dimensions of 50 mm by 7 mm and a length of 400 mm), cooling water inlet temperature being set at about 5°C.

Extrudate product exiting the cooling die as a continuous slab was analysed and shown to have a moisture level of 25% by weight and a water activity of 0.68. The slab was then conveyed directly to the modified hammer mill. The product slab was cut and shredded into pieces of torn, non-uniform appearance, quite similar to canned white tuna pieces. The rotational speed of



the hammer discs was set to 1800 - 2000 rpm, whilst a screen with holes of a size of 50 mm by 7 mm was employed.

The shredded pieces obtained had an appearance similar to that of shredded tuna meat. This material has a shelf life in excess of 12 months in  
5 ambient conditions.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method for manufacturing a texturised proteinaceous meat analogue product, said product having a relative water activity of lower than about 0.8 and including about 20 to 80% by weight edible proteinaceous materials selected from the group consisting of predetermined mixtures of defatted soy flour, soy meal, soy concentrate, cereal gluten (in vital or starch-containing form) and egg white powder; up to about 5% by weight of edible mineral binding and cross-linking compounds; and up to about 50% by weight of an edible humectant system consisting of a mixture of glycerol and glucose in a predetermined ratio; said method including:

subjecting, in an extruder, a mixture of materials as defined above, to mechanical pressure and heat sufficient to convert the mixture into a hot protein lava; and

extruding the protein lava through and from a temperature controlled cooling die which cools and increases the viscosity of the protein lava to obtain a cohesive, texturised, extrudate slab or ribbon in which vapour-flashing is substantially inhibited.

2. The method of claim 1, wherein said mixture contains about 25% by weight glycerol and about 5% by weight of glucose.

3. The method of any preceding claim, wherein said meat analogue product has a relative water activity of between about 0.55 and about 0.68.

4. The method of any preceding claim, wherein said extruder is a twin-screw extruder with between four and six barrel sections and a screw speed operating in the range 300rpm to 550rpm.

5. The method of claim 4, wherein said extruder has five barrel sections and said screw speed is about 500rpm.

6. The method of claims 4 or 5, wherein each extruder barrel section has a length to diameter ratio of about 4.
7. The method of any preceding claim, wherein the temperature of said protein lava is restricted to less than about 120°C.
8. The method of any preceding claim, wherein the solidified extrudate slab or ribbon is further subjected to suitable size-reduction techniques for producing extrudate shreds that resemble in consistency and texture flaked or shredded meat.
9. The method of claim 8, wherein said size-reduction includes shredding in a hammer mill.
10. The method of claim 9, wherein said hammer mill includes a cage plate with a plurality of elongate discharge openings and a plurality of hammer bars hinged to discs attached to a rotating shaft.
11. The method of claim 10, wherein the extrudate is transferred directly from the cooling die to the hammer mill.
12. The method of any preceding claim, further including the step of adding meat based product into said mixture.
13. The method claim 12, wherein said meat-product is added directly to said protein lava.
14. The method of any preceding claim, wherein said mixture has a total moisture content of between about 15% and about 40% by mass.
15. The method of any preceding claim, wherein said mixture includes:  
  
a dry ingredient blend, said dry ingredient blend making up about 50% of meat analogue product mass and including (by mass) about 40% defatted soy

flour, about 40% vital wheat gluten, about 0.5% nutritional vitamin supplements, about 8.5% mineral supplements, about 2.0% flavouring agents, about 4.3% colouring agents and about 4.7% carbohydrate;

a humectant blend, said humectant blend making up about 30% of meat analogue product mass and including about 83% glycerol and about 17% glucose by mass; and

meat based material, said meat based material making up about 20% of extrudate mass and consisting of comminuted material derived from one or more animals selected from the group consisting of poultry, fish, ovines, bovines and porcines.

16. A meat analogue product produced by a process according to any preceding claim.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU03/01045

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
Int. Cl. <sup>7</sup> : A23J 3/22, A23B 7/08		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols) AS BELOW		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AS BELOW		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) WPIDS, FSTA, CA and Internet. Keywords : soy, soya, egg, meat, protein, flour, gluten, glycerol, glucose		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO, A, 01/17364 (EFFEM FOODS PTY LTD) 15 March 2001. (see page 12 line 1 - 24 - p. 13 line 18, claim 22)	1 - 16
X Y	HEGENBART, S. Exploring Dimensions in Intermediate Moisture Foods. <a href="http://www.foodproductdesign.com/archive/1993/0793CS.html">http://www.foodproductdesign.com/archive/1993/0793CS.html</a> 19 February 2001 (see in particular paragraphs titled Advancing Technology) <a href="http://www.archive.org/">http://www.archive.org/</a> used to establish the publication date of the document.	1 - 16 1 - 16
Y	WO, A, 00/69276 (EFFEM FOODS PTY LTD) 23 November 2000. (see claims)	1 - 16
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
<p>* Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&amp;" document member of the same patent family</p>		
Date of the actual completion of the international search 11 September 2003		Date of mailing of the international search report 18 SEP 2003
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: <a href="mailto:pct@ipaaustralia.gov.au">pct@ipaaustralia.gov.au</a> Facsimile No. (02) 6285 3929		Authorized officer  ALISTAIR BESTOW Telephone No : (02) 6283 2450

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU03/01045

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4070490 (LUGAY, J. C., ET. AL.) 24 January 1978. (See col. 3 line 27 - 61, Example 1)	1 - 16
A	TAOUKIS, P. S. et. al. Intermediate-Moisture Foods <a href="http://www.fsci.umn.edu/Ted_Labuza/papers/IMF.pdf">http://www.fsci.umn.edu/Ted_Labuza/papers/IMF.pdf</a>	1 - 16
A	US, A, 3202514 (BURGESS, H. M. et. al.) 24 August 1965. Whole document.	1 - 16

## INTERNATIONAL SEARCH REPORT

International application No.

Information on patent family members

PCT/AU03/01045

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
WO	200117364	AU	200072616	CA	2383578	EP	1229802
		HU	200202723	AU	20005182		
WO	200069276	AU	200048999	CA	2373622	EP	1182937
		HU	200201482	NZ	515052	ZA	200109038
US	4070490	BE	852064	CA	1077770	CH	600789
		DE	2708818	DK	788/77	FR	2343431
		GB	1531376	JP	52107975	NL	7702348
		YU	597/77				
END OF ANNEX							